Small Business Innovation Research/Small Business Tech Transfer

Reconfigurable VTOL Energy Management System, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

This SBIR Phase I develops hardware and software for energy management in electric VTOL aircraft. It focuses on techniques to ensure short-time-scale stability in power micro-grids, and optimization-based control at somewhat longer (~10-100 ms) time-scales for propulsion system and vehicle control, which is managed by a vehicle Energy Management System (vEMS). Fast optimization and model-based decision making are key to the approach. Experiments will be conducted with a hybrid power plant consisting of an internal combustion engine, an iron-less dual-halbach-array starter motor/generator, and a new 6-phase regenerative motor drive. The project is organized into three Technical Objectives:

TO #1: Reconfigurable Component, Subsystem, and System Topology Models

Reconfigurability is enabled at three levels in the vEMS-controlled system. At the component level, parametric models are used so that components in a new vehicle system or a faulted system can be configured with a parameter list. Subsystems are similarly configured. At the system level, the topology is reconfigurable because of technical conditions (incremental passivity) placed on each component to ensure that the assembled micro-grid is stable regardless of the interconnection. With stable short-time-scale dynamics, the vEMS uses component models to optimally manage interactions on the micro-grid.

TO #2: Incremental Passivity with Application to a 1.5kW Regenerative Drive

LaunchPoint proposes to design a 1.5kW regenerative drive for the 6-phase starter motor/generator such that it is incrementally passive as seen from the bus.

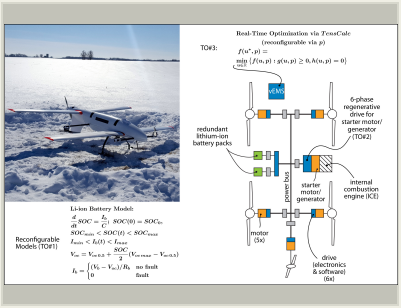
TO #3: Real-Time Optimal Control for Energy Management

The project will make use of a recently developed tool, named *TensCalc*, that generates specialized C-code for real-time decision and control with up to a few thousand optimization variables/constraints. This fast optimization tool will be at the heart of the vEMS system and enable millisecond time-scale decision making.

Anticipated Benefits

This project relates to NASAs efforts in electric and hybrid-electric flight, urban air mobility (UAM) and research in power electronics. NASA vehicles and concepts related to this work are the X-57, GL-10, and SUGAR Volt.

The US Department of Defense and number of companies are developing or have interest in electric and hybrid-electric flight. Commercial entities include Uber, Amazon, Vayu, Elroy Air, Martin Aerospace, Boeing, and numerous



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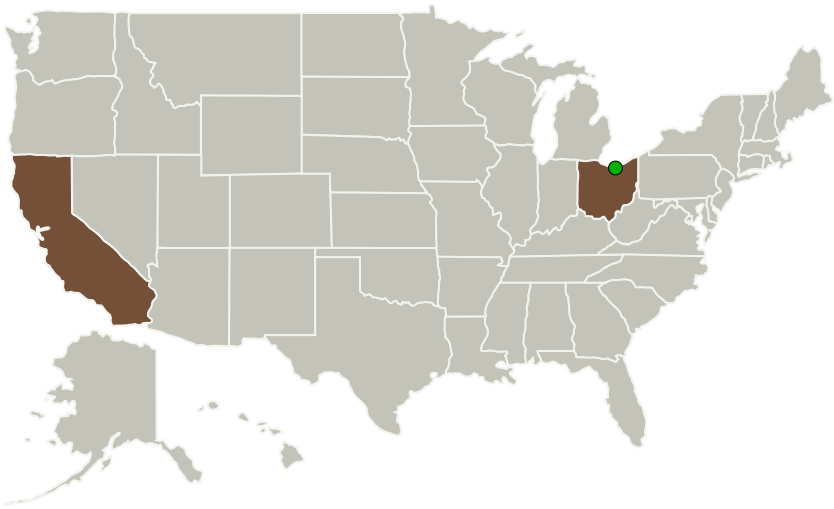
others.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
LaunchPoint Technologies, Inc.	Lead Organization	Industry	Goleta, California
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
California	Ohio

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137893)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

LaunchPoint Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

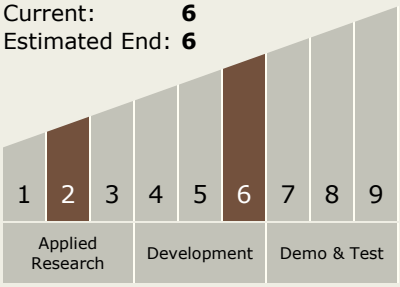
Carlos Torrez

Principal Investigator:

Jessica A Dozoretz

Technology Maturity (TRL)

Start: **2**
Current: **6**
Estimated End: **6**



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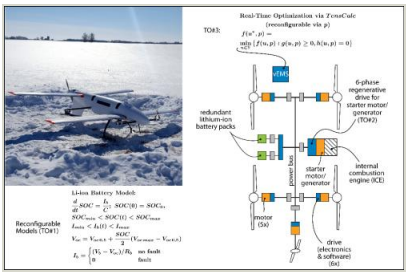
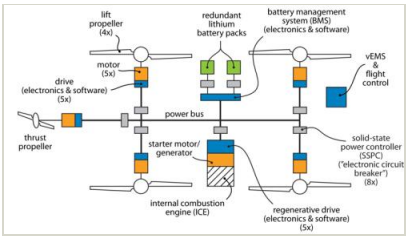
Images



Briefing Chart Image
Reconfigurable VTOL Energy Management System, Phase I *(https://techport.nasa.gov/image/130204)*



Final Summary Chart Image
Reconfigurable VTOL Energy Management System, Phase I *(https://techport.nasa.gov/image/134948)*

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.3 Aero Propulsion
    - TX01.3.9 Hybrid Electric Systems

Target Destination

Earth